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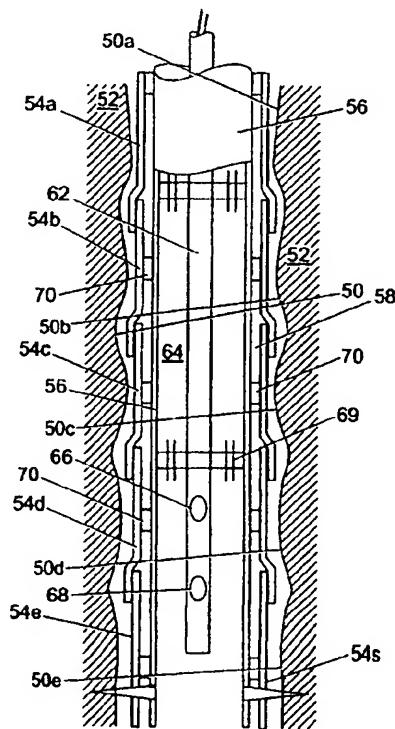
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{Continued on next page}

(54) Title: METHOD OF AND APPARATUS FOR CASING A BOREHOLE

(57) Abstract: Methods of and apparatus for drilling, casing and/or completing a borehole (50) wherein one or more portions (50a to 50e) of the borehole (50) are drilled into a formation (52) at a single diameter along the entire length or depth of the or each portion (50a to 50e) of the borehole (50). An expandable tubular member (54a to 54e) is then located within the or each portion (50a to 50e) of the borehole (50) and radially expanded in the or each portion (50a to 50e) to line and/or case it or them. Optionally, a corrosion resistant member (56) and/or a service string (62) can be located in the borehole (50). An advantage of certain embodiments is that a single diameter borehole (50) is formed along the entire length or depth thereof.



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1       "Method of and Apparatus for Casing a Borehole"

2

3       The present invention relates to a method of  
4       drilling, casing and/or completing a borehole, and  
5       in particular to a method of drilling, casing and/or  
6       cladding a borehole. The invention also provides  
7       apparatus for completing a borehole. It will be  
8       understood that use of the term "borehole" herein is  
9       a reference to a bore that has been drilled into a  
10      formation to allow the recovery of hydrocarbons (or  
11      other fluids) therefrom as is conventional in the  
12      art.

13

14      When a borehole has been drilled into a formation to  
15      facilitate, for example, the recovery of  
16      hydrocarbons from a well or reservoir, the formation  
17      surrounding the borehole is typically lined with a  
18      casing. Casing is installed to prevent the  
19      formation around the borehole from collapsing, and  
20      additionally to prevent unwanted fluids flowing from  
21      the surrounding formation into the borehole, and

1 similarly, to prevent fluids from within the  
2 borehole escaping into the surrounding formation.

3

4 Referring to Fig. 1 there is shown a conventional  
5 borehole 10 that has been drilled into a formation  
6 12. It should be noted that Fig. 1 is not to scale.  
7 Borehole 10 is drilled with a relatively large  
8 diameter at or near surface 14, and it will be  
9 appreciated that surface 14 could be below sea  
10 level.

11

12 A relatively large outer diameter (OD) casing 16 is  
13 then inserted into borehole 10 and cemented into  
14 place using cement 18 in a conventional manner. The  
15 cementing process typically involves filling an  
16 annulus between the casing 16 and the surrounding  
17 formation 12 with the cement 18 by pumping the  
18 cement 18 into the casing 16 followed by a rubber or  
19 other plug (not shown) on top of the cement 18.  
20 Thereafter, drilling fluid or the like is pumped  
21 down the casing 16 above the plug and the cement 18  
22 is pushed out of the bottom of the casing 16 and up  
23 into the annulus between the casing 16 and the  
24 formation 12, as shown in Fig. 1. Pumping of  
25 drilling fluid (and thus the cement 18) is stopped  
26 when the plug reaches the bottom of the casing 16  
27 and the borehole 10 must be left, typically for  
28 several hours, whilst the cement sets.

29

30 Thereafter, a smaller diameter borehole 20 is  
31 drilled through the cement 18 into the formation 12  
32 and a subsequent casing 22 of smaller OD than the

1 casing 16 is passed through the casing 16 above and  
2 the borehole 20. The diameter of the drill bit that  
3 is used to drill borehole 20 is typically smaller  
4 than the drill bit used to drill borehole 10, and is  
5 typically smaller than an inside diameter (ID) of  
6 the casing 16. Casing 22 is then cemented into  
7 place using cement 24 in the conventional manner, as  
8 described above. The OD of the subsequent casing 22  
9 is limited by the inner diameter of the preceding  
10 casing 16. The cement 24 is then left for a further  
11 period of several hours to set.

12

13 A smaller diameter borehole 26 is then drilled into  
14 the cement 24 and into the formation 12, and another  
15 casing 28 is then passed through borehole 26 and the  
16 casing 22 above. As before, the diameter of the  
17 drill bit used to drill borehole 26 is typically  
18 smaller than the drill bit used to drill boreholes  
19 10, 20, and typically smaller than the ID of the  
20 casing 22. Casing 28 is then cemented into place  
21 using cement 30 in the conventional manner described  
22 above. The cement 30 is typically left for a  
23 further period of several hours to set. The ID of  
24 the casing 22 thus limits the OD of casing 28.

25

26 Finally, a smaller diameter borehole 32 is drilled  
27 into cement 30 and into formation 12, and another  
28 casing 34 of smaller OD than casing 28 is passed  
29 through casing 28. Again, the diameter of the drill  
30 bit used to drill borehole 32 is smaller than those  
31 used to drill the preceding boreholes 10, 20, 26,  
32 and smaller than the ID of casing 28. Cement 36 is

1   then used to secure casing 34 within borehole 32  
2   using the conventional manner described above. The  
3   cement 36 is typically left for a further period of  
4   several hours to set.

5

6   Thus, the casings 16, 22, 28, 34 are cascaded with  
7   the diameters of the successive portions of casing  
8   reducing as the depth of the borehole 10, 20, 26, 32  
9   increases. It will be appreciated that the depth of  
10   the borehole 10, 20, 26, 32 may be in the order of  
11   several kilometres and the example shown in Fig. 1  
12   is representative only.

13

14   The successive reduction in diameter of casing  
15   results in a casing with a relatively small ID near  
16   the bottom of the borehole 32 at or near a formation  
17   payzone. The narrow ID could limit the amount of  
18   hydrocarbons that can be recovered. In addition,  
19   the relatively large diameter borehole 10 at the top  
20   of the well involves increased costs due to the  
21   large drill bits required, heavy equipment for  
22   handling the larger casing, and increased volumes of  
23   drill fluid that are required.

24

25   Once the casing portions 16, 22, 28, 34 have been  
26   cemented into place, the borehole is then  
27   "completed". This involves installing a completion  
28   string 38 within the IDs of the casing portions 16,  
29   22, 28, 34. The OD of the completion string 38 is  
30   thus limited by the ID of the lowermost casing 34,  
31   which in turn is limited by the IDs of the casings  
32   16, 22, 28 above, and this can limit the amount of

1       hydrocarbons that can be recovered from a reservoir  
2       40. The completion string 38 is typically of a  
3       corrosion resistant material as corrosive chemicals  
4       in the formation 12 and/or the reservoir 40 such as  
5       H<sub>2</sub>S can be mixed with the hydrocarbons from the  
6       reservoir 40 flowing up through the string 38 to the  
7       surface 14. The flow of hydrocarbons is indicated  
8       schematically by arrows 42 in Fig. 1.

9

10      A packer 44 or the like is used at or near a lower  
11      end of the lowermost casing 34 to isolate the  
12      annulus and thus prevent hydrocarbons from flowing  
13      up it. Also, a safety valve (not shown) is  
14      typically located in the completion string 38 at or  
15      near an upper end thereof, and is used to prevent  
16      the flow of hydrocarbons to the surface in the event  
17      of an emergency, as is known in the art. The  
18      completion string 38 may also contain various flow  
19      control devices to control the flow of hydrocarbons,  
20      and downhole sensing and measuring apparatus to  
21      monitor the flow rate, temperature and other  
22      parameters of the produced fluids.

23

24      According to a first aspect of the present invention  
25      there is provided a method of drilling and casing a  
26      borehole, the method comprising the steps of a)  
27      drilling a portion of the borehole into a formation,  
28      b) providing an expandable tubular member, c)  
29      running the tubular member into the portion of the  
30      borehole, and d) radially expanding the member.

31

1     The method preferably includes the additional steps  
2     of drilling one or more further portions of the  
3     borehole extending from the existing portion of the  
4     borehole, providing one or more further expandable  
5     members, running the or each expandable member into  
6     the or each further portions of the borehole, and  
7     radially expanding the or each member in the or each  
8     further portion of the borehole. This process can  
9     then be repeated until the required depth of the  
10    overall borehole is reached.

11

12    Preferably, the or each portion of the borehole is  
13    drilled at approximately the same diameter as the  
14    existing portion(s) of the borehole. Thus, all  
15    boreholes are drilled and cased at substantially the  
16    same diameter. This is advantageous because it  
17    requires only a single sized drill bit to be used  
18    instead of a number of different sized bits, and  
19    also reduces the amount of time spent in drilling  
20    and casing as there is no requirement to change to  
21    different sized bits as the borehole increases in  
22    depth.

23

24    The or each portion of the borehole typically  
25    extends the borehole into the formation from the or  
26    each existing portion. Alternatively, or  
27    additionally, the or each portion of the borehole  
28    may comprises one or more lateral and/or horizontal  
29    boreholes drilled from the or each existing  
30    borehole.

31

1 According to a second aspect of the present  
2 invention there is provided apparatus for casing a  
3 borehole, the apparatus comprising a length of  
4 expandable tubular member, and an expander device  
5 that is capable of radially expanding the member in  
6 the borehole.

7

8 A drill bit is typically used to drill the or each  
9 portion of the borehole into the formation. The  
10 drill bit is typically provided with one or more  
11 cutting elements that are preferably capable of  
12 assuming a retracted configuration and an extended  
13 configuration. In the retracted configuration, the  
14 drill bit can be passed through expandable members  
15 that have been expanded into contact with the  
16 borehole. In the expanded configuration, the drill  
17 bit can be used to drill a borehole below an  
18 expandable member that has been previously  
19 installed. An underreamer may be used, for example.  
20

21 Alternatively, a single diameter drill bit can be  
22 used together with an underreamer.

23

24 The or each expandable tubular member can be of a  
25 length that is substantially the same length as the  
26 or each portion of the borehole. This provides the  
27 advantage that the entire length of the or each  
28 portion of the borehole can be cased using the same  
29 member. The or each length of expandable tubular  
30 member can be provided by coupling discrete lengths  
31 of expandable tubular member together (e.g. using

1 screw threads), or by using a roll, reel, coil or  
2 the like of expandable tubular member.

3 Alternatively, the or each length of tubular member  
4 may comprise a plurality of discrete lengths that  
5 are inserted into the or each portion of the  
6 borehole in an overlapping arrangement so that an  
7 upper end of a subsequent member overlaps a lower  
8 end of a previous member.

9

10 The or each expandable tubular member is typically  
11 radially expanded until at least a portion of an  
12 outer surface of the member contacts an inner  
13 surface of the or each portion of the borehole. It  
14 will be appreciated that the outer surface of the  
15 member need not contact the or each portion of the  
16 borehole. For example, the expandable tubular  
17 member may be provided with a friction and/or  
18 sealing material (e.g. rubber) on its outer surface,  
19 where the material typically contacts the or each  
20 portion of the borehole. Alternatively, the  
21 expandable tubular member (with or without a  
22 friction and/or sealing material) can be radially  
23 expanded within the or each portion of the borehole  
24 so that an annulus is created between an outer  
25 surface of the member and the or each portion of the  
26 borehole, the annulus then being filled with cement  
27 to hold the member in place.

28

29 Also, one or more spacers or the like may be used  
30 between the or each expandable tubular member and  
31 the or each portion of the borehole.

32

1       The method typically includes one, some or all of  
2       the additional steps of providing an expander  
3       device, and running the expander device into the  
4       expandable tubular member to radially expand the  
5       member.

6

7       Optionally, the method includes one, some or all of  
8       the additional steps of resting the or each  
9       expandable tubular member on a portion of the  
10      expander device, and pushing or pulling the expander  
11      device though the member to radially expand the  
12      member in the or each portion of the borehole.

13

14      Optionally, the method includes the additional step  
15      of anchoring at least a portion of the member,  
16      typically at or near a starting position of the  
17      expander device.

18

19      The method typically includes the additional steps  
20      of providing a drill string, coiled tubing string or  
21      the like, and attaching the expander device to the  
22      string.

23

24      Optionally, the method includes one, some or all of  
25      the additional steps of providing a corrosion  
26      resistant expandable tubular member, running the  
27      corrosion resistant expandable tubular member into  
28      the or each portion of the borehole, and radially  
29      expanding the corrosion resistant member.

30

31      The corrosion resistant member is typically located  
32      within the expandable tubular member. The corrosion

1     resistant member is typically radially expanded  
2     until a portion thereof (e.g. an outer surface)  
3     contacts the expandable tubular member. It will be  
4     appreciated that the corrosion resistant member need  
5     not contact the expandable tubular member. A spacer  
6     or the like may be used therebetween, or a friction  
7     and/or sealing material applied to the outer surface  
8     of the corrosion resistant tubular member. Also,  
9     cement may be used between the members.

10  
11    The corrosion resistant expandable tubular member is  
12    typically of a length that is substantially the same  
13    length as the or each portion of the borehole and/or  
14    the or each expandable tubular member. This  
15    provides the advantage that the entire length of the  
16    or each portion of the borehole can be cased using  
17    the same member. The length of the or each  
18    corrosion resistant expandable tubular member can be  
19    provided by coupling discrete lengths of corrosion  
20    resistant expandable tubular members together (e.g.  
21    using screw threads), or by using a roll, coil, reel  
22    or the like of corrosion resistant expandable  
23    tubular member. Alternatively, the length of  
24    corrosion resistant tubular member may comprise a  
25    plurality of discrete lengths that are inserted into  
26    the or each portion of the borehole in an  
27    overlapping arrangement so that a lower end of an  
28    upper member overlaps an upper end of a subsequent  
29    member. The corrosion resistant tubular member  
30    typically has a relatively thin wall thickness (e.g.  
31    in the order of 5mm or less).

1     Typically, at least a portion of the outer surface  
2     of the corrosion resistant tubular member contacts  
3     an inner surface of the expandable tubular member,  
4     although this is not essential.

5

6     The corrosion resistant tubular member is typically  
7     required where the expandable tubular member is not  
8     corrosion resistant so that the hydrocarbons and  
9     other production fluids such as corrosive agents can  
10    flow up the corrosion resistant tubular member to  
11    the surface. Of course, the original expandable  
12    tubular member may be of a corrosion resistant  
13    material (or coated therewith) and thus there would  
14    be no requirement for a second member of corrosion  
15    resistant material. Additionally, the expandable  
16    tubular member and/or the corrosion resistant  
17    tubular member obviate the need to have an internal  
18    completion string to facilitate the recovery of  
19    hydrocarbons and eliminate an annulus between the  
20    completion string and the casing.

21

22    Preferably, the method includes the additional step  
23    of providing a service string within the expandable  
24    tubular member. The service string is typically  
25    required as there is no annulus between the  
26    conventional completion string and the casing that  
27    is typically used for control cables and the like  
28    that control operation of various downhole tools and  
29    apparatus (e.g. packers, flow control devices,  
30    safety valves or the like), and electrical cables,  
31    wires etc.

32

1       The apparatus optionally includes a corrosion  
2       resistant tubular member. This member serves to  
3       facilitate the flow of hydrocarbons from a  
4       reservoir, well or the like to the surface.

5

6       The apparatus preferably includes a service string  
7       or the like. The service string is typically  
8       located within the expandable and/or corrosion  
9       resistant member and is typically used as a conduit  
10      to house cables, wires and the like that are  
11      typically used to control downhole tools, apparatus  
12      and instruments. The service string may be provided  
13      with downhole apparatus and instruments (e.g. flow  
14      meters, temperature sensors etc).

15

16      The recovered hydrocarbons typically flow up an  
17      annulus between the service string and the  
18      expandable tubular member and/or the corrosion  
19      resistant tubular member.

20

21      The service string typically comprises a corrosion  
22      resistant tubular member. However, the service  
23      string may comprise any downhole tubular, such as a  
24      string of casing, liner or the like. The service  
25      string may comprise a roll or coil of tubing, or can  
26      be discrete lengths of preferably corrosion  
27      resistant tubular members that are coupled together  
28      (e.g. using screw threads). The corrosion resistant  
29      tubular member typically has a relatively thin wall  
30      thickness (e.g. of around 5mm or less).

31

1      The or each tubular member is preferably  
2      manufactured from a ductile material. Thus, the or  
3      each tubular member is capable of sustaining plastic  
4      deformation.

5

6      Typically, the or each tubular member is a casing,  
7      liner, drill pipe, pipeline, conduit or the like.

8

9      The expander device is typically manufactured from  
10     steel, a steel alloy, tungsten carbide etc.

11     Alternatively, the expander device may be  
12     manufactured from ceramic, or a combination of  
13     steel, ceramic, tungsten carbide etc. The expander  
14     device is optionally flexible. The expander device  
15     is typically of a material that is harder than the  
16     member that is has to expand. It will be  
17     appreciated that only the portion(s) of the expander  
18     device that come into contact with the member need  
19     be of a harder material and/or coated therewith.

20

21     The expander device is optionally provided with at  
22     least one seal. The seal typically comprises at  
23     least one O-ring.

24

25     The expander device is typically pushed or pulled  
26     through the or each tubular member, pipeline,  
27     conduit or the like using fluid pressure.

28     Alternatively, the device may be pigged along the or  
29     each tubular member or the like using a conventional  
30     pig or tractor. The device may also be pushed using  
31     a weight (from the string for example), or may be  
32     pulled through the or each tubular member or the

1 like (using drill pipe, rods, coiled tubing, a  
2 wireline or the like).

3

4 The or each tubular member is optionally temporarily  
5 anchored at an upper or lower end thereof using a  
6 mechanical or other anchoring device (e.g. a slip or  
7 packer), and facilitates radial expansion thereof.

8

9 An outer surface of the or each tubular member may  
10 be provided with a friction and/or sealing material  
11 that enhances the grip on the borehole or other  
12 member. The formation typically comprises one or  
13 more types of a resilient material.

14

15 Embodiments of the present invention shall now be  
16 described, by way of example only, with reference to  
17 the accompanying drawings in which:

18 Fig. 1 is a schematic representation of a prior  
19 art method of drilling and casing a borehole;

20 Fig. 2 is an exemplary embodiment of apparatus  
21 for casing a borehole;

22 Fig. 3a is a front elevation showing a first  
23 configuration of a formation that can be  
24 applied to an outer surface of a portion of the  
25 apparatus of Fig. 2;

26 Fig. 3b is an end elevation of the formation of  
27 Fig. 3a;

28 Fig. 3c is an enlarged view of a portion of the  
29 formation of Figs 3a and 3b showing a profiled  
30 outer surface;

31 Fig. 4a is a front elevation of an alternative  
32 formation that can be applied to an outer

1       surface of a portion of the apparatus of Fig.  
2       2; and

3       Fig. 4b is an end elevation of the formation of  
4       Fig. 4a.

5

6       Referring to the drawings, Fig. 2 shows a particular  
7       embodiment of apparatus for casing a borehole 50  
8       that has been drilled into a formation 52 as is  
9       known in the art. The borehole 50 generally  
10      facilitates the recovery of hydrocarbons (or other  
11      fluids) from a reservoir or pay zone (not shown in  
12      Fig. 2).

13

14      Like conventional methods for drilling boreholes,  
15      borehole 50 is made up of a number of individually  
16      drilled portions of borehole, illustrated in Fig. 2  
17      as boreholes 50a to 50e. It will be appreciated  
18      that Fig. 2 is not to scale and shows only a portion  
19      of the overall borehole 50 and the apparatus, and  
20      the number of individual portions of borehole 50a to  
21      50e that are required will vary depending upon the  
22      length or depth of the overall borehole 50.

23

24      However, unlike conventional methods, the overall  
25      borehole 50 is drilled at a single diameter along  
26      its entire length or depth. This is achieved by  
27      drilling subsequent portions of borehole 50b to 50e  
28      through the first portion of borehole 50a at  
29      substantially the same diameter as the first portion  
30      of borehole 50a. A single diameter bit that is  
31      provided with one or more cutting elements can be  
32      used, where the or each cutting element is capable

1       of being moved between a retracted configuration and  
2       an extended configuration. In this way, the drill  
3       bit in the retracted configuration can be inserted  
4       through the first portion of borehole 50a that has  
5       already been drilled and cased, and then the or each  
6       cutting element can be moved to the extended  
7       configuration (e.g. by applying fluid pressure to  
8       the bit). Thus, the subsequent portions of the  
9       borehole 50b to 50e drilled can have substantially  
10      the same diameter as the preceding portions of the  
11      borehole 50a to 50d.

12

13      The apparatus includes a length of expandable casing  
14      54 that is preferably a single length of casing that  
15      is substantially the same length (or depth) as each  
16      individual portion of the borehole 50a to 50e. The  
17      casing 54 is shown in Fig. 2 as a number of casing  
18      portions of a discrete length with an overlap  
19      between each portion. However, it is possible to  
20      have the casing 54 made from a single piece of  
21      casing so that there is no overlap, although it is  
22      also possible to have a number of casing portions  
23      that are coupled together (e.g. by welding or screw  
24      threads) so that there is no overlap between  
25      successive casing portions. The casing 54 may be in  
26      the form of a roll, reel or coil of casing as is  
27      known in the art.

28

29      Casing 54 is preferably manufactured from a ductile  
30      material so that it is capable of sustaining plastic  
31      and/or elastic deformation. Casing 54 is typically

1       of carbon steel or a corrosion resistant alloy for  
2       example.

3

4       In use, the first portion of the borehole 50a is  
5       initially drilled so that the entire length or depth  
6       of the first portion of the borehole 50a is of  
7       substantially the same diameter. The diameter is  
8       typically slightly greater than an outer diameter  
9       (OD) of the casing 54 in an unexpanded state. The  
10      casing 54 is typically capable of sustaining plastic  
11      deformation to expand its OD by around 10% at least,  
12      although radial plastic deformation in the order of  
13      20% or more is possible. Thus, the diameter of the  
14      first portion of the borehole 50a (and thus the  
15      overall borehole 50) will be dependent upon the  
16      material used for the casing 54 and also the  
17      percentage of radial plastic deformation. It will  
18      be appreciated that use of the term radial plastic  
19      deformation is understood to be the use of an  
20      expander device (not shown) that is pushed or pulled  
21      through the casing 54 to impart a radial expansion  
22      force to the casing so that both the ID and the OD  
23      of the casing 54 increases.

24

25      Once the first portion of the borehole 50a has been  
26      drilled, it is typically lined or cased to prevent  
27      it from collapsing. In its simplest embodiment, a  
28      length of expandable casing 54a is inserted into the  
29      first portion of the borehole 50a. The length of  
30      the casing 54a is substantially the same as the  
31      depth or length of the first portion of the borehole  
32      50a. After the casing 54a has been run into the

1       first portion of the borehole 50a, an expander  
2       device is then forced through the casing 54a to  
3       radially expand at least a portion thereof, and  
4       preferably the entire length, so that the outer  
5       surface of the casing 54 preferably contacts the  
6       inner wall of the first portion of the borehole 50a.  
7       It will be appreciated that the outer surface of  
8       casing 54a need not contact the inner wall of the  
9       first portion of the borehole 50a, as will be  
10      described.

11

12      The length of casing 54a may be in a number of  
13      different forms, for example, the length of casing  
14      54a could be from a roll, reel or coil of expandable  
15      tubing. Alternatively, the casing 54a can be made  
16      up from a plurality of discrete lengths of casing  
17      that are coupled together (e.g. by welding, screw  
18      threads or the like), or overlapped at each end.

19

20      It is preferred, but not essential, that the entire  
21      length of the casing 54a is expanded in one pass of  
22      an expander device (not shown) through the casing  
23      54a. The expander device is typically a cone that  
24      is forced through the casing 54a to impart a radial  
25      expansion force to the casing 54a. The device can  
26      be of metal or a metal alloy (e.g. steel, tungsten  
27      carbide), ceramic or a combination of these  
28      materials and typically has an OD that is  
29      substantially the same as or slightly less than the  
30      final required ID of the (expanded) casing 54a. In  
31      this way, the first portion of the borehole 50a can

1       be cased in one trip of the device through the  
2       casing 54a.

3

4       The pliable casing 54a undergoes plastic deformation  
5       when expanded by the expander device as it is  
6       propelled, pushed or pulled through the casing 54a.  
7       The expander device can be propelled along the  
8       casing 54a in a similar manner to a pipeline pig and  
9       may be pushed (using weight or fluid pressure for  
10      example) or pulled (using drill pipe, rods, coiled  
11      tubing, a wireline or the like).

12

13      The expander device is typically attached to a drill  
14      string, coil tubing string or the like and can be  
15      inserted into a lower part of the casing 54a that  
16      has been pre-expanded to house the device.

17      Thereafter, the device is pulled through the casing  
18      54a to impart a radial expansion force by pulling  
19      the drill string, coiled tubing string etc out of  
20      the casing 54a. Where the expander device is  
21      located in a pre-expanded portion of the casing 54a,  
22      the casing 54a can be rested on top of the device  
23      and lowered into the first portion of the borehole  
24      50a using the drill string, coiled tubing string or  
25      the like.

26

27      Alternatively, the expander device can be propelled  
28      or pushed through the casing 54a using a pig,  
29      tractor, fluid pressure or the like. It is possible  
30      that the expander device can be located at the top  
31      of the casing and propelled (using a tractor) or  
32      pushed (using fluid pressure, a drill string, or

1 weight from the string) through the casing 54a to  
2 impart a radial expansion force thereto.

3

4 The casing 54a may need to be temporarily anchored  
5 in the first portion 50a of the borehole 50 using a  
6 device, such as a packer, slips or the like.  
7 However, where the expander device includes an  
8 inflatable element (e.g. a packer), then the  
9 inflatable element can be inflated in the pre-  
10 expanded portion (or elsewhere) thus forcing it  
11 radially outwards into contact with the first  
12 portion 50a of the borehole 50 and this provides an  
13 anchor for pulling the device through the casing  
14 54a. The expander device (e.g. a cone) can be  
15 releasably attached to the inflatable element so  
16 that the inflatable element can be left in the  
17 casing 54a to act as an anchor during expansion  
18 thereof.

19

20 The expandable casing 54a does not require to be  
21 cemented into place as it is typically held against  
22 the first portion 50a of the borehole 50 due to  
23 physical contact between an outer surface of the  
24 casing 54a and an inner wall of the first portion  
25 50a of the borehole 50, although cementing remains  
26 an option. The casing 54a need not contact the  
27 borehole 50 itself; it may be provided with a  
28 friction and/or sealing material, or other type of  
29 spacer or seal, between the casing 54a and the first  
30 portion 50a of the borehole 50. Thus, significant  
31 savings in terms of rig time and costs are provided  
32 as it is no longer necessary to cement each length

1       of conventional casing into place, the cement  
2       typically being left for several hours to cure. As  
3       each casing is of a different diameter, a borehole  
4       of equivalent or slightly larger diameter must be  
5       drilled into the formation for each diameter of  
6       casing which is then cemented into place, taking  
7       several hours to cure.

8

9       Once the first portion 50a of the borehole 50 has  
10      been drilled and the casing 54a installed, as  
11      described above, a second portion 50b of the  
12      borehole 50 is then drilled. The second portion 50b  
13      of the borehole 50 can be drilled using an  
14      expandable bit (e.g. a drill bit that is capable of  
15      assuming two different configurations). The  
16      expandable bit typically has a plurality of cutting  
17      elements that can be moved between first and second  
18      configurations. In the first configuration, the  
19      cutting elements are typically retracted so that the  
20      drill bit can be passed through the bore of  
21      previously drilled boreholes and/or pre-installed  
22      casings, liners etc. Once the bit has passed  
23      through the bores, the cutting elements can then be  
24      extended (e.g. by fluid pressure, centrifugal force  
25      or the like) to assume a cutting diameter that is  
26      slightly greater than the final or expanded outer  
27      diameter of the casing, liner etc.

28

29       Alternatively, the or each borehole portion 50b to  
30       50e can be drilled using a drill bit of a fixed  
31       diameter, and then an underreamer used to enlarge

1       the bore below a pre-installed portion of casing to  
2       allow a second casing to be installed therebelow.

3

4       Thus, the second portion 50b of the borehole 50 is  
5       drilled at substantially the same diameter as the  
6       first portion 50a of the borehole 50. Thus, there  
7       is no requirement to provide drill bits of varying  
8       cutting diameter to produce boreholes that reduce in  
9       diameter as the length or depth of the borehole  
10      increases, thus saving costs. Further, there is no  
11      requirement to provide casing or liner having  
12      different diameters, again saving costs. Further  
13      cost and time savings can be made as there is no  
14      requirement to change drill bits to vary the cutting  
15      diameter and the time taken to perform this.

16

17      Having drilled the second portion 50b of the  
18      borehole 50, a second casing 54b, similar to casing  
19      54a, is then installed and expanded into place as  
20      described above with reference to casing 54a. This  
21      has significant advantages as the casing 54a, 54b  
22      can be expanded sufficiently so that an outer  
23      surface 54s of each casing 54a, 54b contacts an  
24      inner wall of the borehole portions 50a, 50b.  
25      Consequently, the casing 54a, 54b is held in place  
26      due to frictional contact with the wall of the  
27      borehole portions 50a, 50b. Indeed, the casings  
28      54a, 54b can be expanded sufficiently so that they  
29      deform into the formation 52 and remain in place due  
30      to compression of the formation 52. This is  
31      advantageous because the casing 54a, 54b can be held  
32      in place without the use of cement. This, there is

1       no requirement to cement the casing 54a, 54b in  
2       place, thereby saving time and costs because the  
3       borehole portions 50a, 50b does not require to be  
4       left for several hours for each casing 54a, 54b to  
5       allow the cement to cure before further boreholes  
6       can be drilled.

7

8       A third portion 50c of the borehole 50 is then  
9       drilled and cased using casing 54c in a similar  
10      manner to that described above. Further portions  
11      50d, 50e of the borehole 50 can then be drilled and  
12      cased using casing 54d, 54e and so on until the  
13      overall borehole 50 is at the required depth or  
14      length. Thus, the entire borehole 50 is drilled at  
15      substantially the same diameter over the full length  
16      or depth. Further advantages of embodiment of the  
17      present invention is that the entire length or depth  
18      of the overall borehole 50 can have a diameter that  
19      is sufficient to facilitate effective and non-  
20      restricted production of hydrocarbons and other  
21      fluid therefrom. This means that production from  
22      the borehole 50 can be increased, without adding to  
23      the costs and providing time savings in gaining  
24      access to the pay zone.

25

26      It will be appreciated that an upper end of the  
27      subsequent casings 54b to 54e typically overlap a  
28      lower end of the previously installed casing (e.g.  
29      casing 54a), as shown in Fig. 2.

30

31      It will be noted that drilling the borehole 50 at a  
32      single diameter over its entire length using

1 individual borehole portions 50a to 50e of  
2 substantially the same diameter, has other  
3 advantages over the conventional method described  
4 with reference to Fig. 1. In particular, the large  
5 drill bits and heavy equipment that are typically  
6 used towards the upper end of the borehole are not  
7 required, thus significantly reducing the costs.  
8 Other benefits and advantages include environmental  
9 benefits as less rock/cuttings are removed from the  
10 borehole that require to be disposed of. Also, only  
11 a borehole of one diameter is required. Thus, there  
12 is no requirement to drill a borehole of a first  
13 diameter using a relatively large drill bit and then  
14 drilling subsequent lower boreholes with drill bits  
15 that gradually reduce in diameter as the depth of  
16 the borehole increases. This significantly reduces  
17 the costs as less rig time is required because the  
18 requirement to periodically change a drill bit to a  
19 different sized bit is obviated. Furthermore, only  
20 a single-sized borehole is required and thus a  
21 plurality of different sized drill bits are not  
22 generally required, which also reduces costs. The  
23 rig time for drilling the borehole is substantially  
24 reduced with respect to conventional methods, as  
25 only a single diameter hole need be drilled over the  
26 entire length of the borehole.  
27  
28 Thus, the method of the present invention provides  
29 significant costs and timesavings as only a single  
30 diameter borehole need be drilled, and the borehole  
31 can be cased using a casing that has a substantially  
32 constant diameter over its entire length. As there

1       is no requirement to drill, case and then cement in  
2       a cascaded manner, the savings in terms of costs and  
3       rig time, rig power, rig size etc are considerable  
4       over conventional methods.

5

6       The outer surface of the casing 54 may optionally be  
7       provided with a friction and/or sealing material.  
8       In this case, the friction and/or sealing material  
9       can be used to enhance the grip of the outer surface  
10      of the casing on the inner wall of the or each  
11      portion 50a to 50e of the borehole 50. Any suitable  
12      type of rubber or other resilient material can be  
13      used for this purpose.

14

15      Referring to Fig. 3, there is shown a formation  
16      generally designated 70, of a friction and/or  
17      sealing material that may be applied to an outer  
18      surface 54s of the casing 54 thereof. The formation  
19      70 typically comprises first and second bands 72, 74  
20      that are axially spaced-apart along a longitudinal  
21      axis of the casing 54. The first and second bands  
22      72, 74 are typically axially spaced by some  
23      distance, for example 3 inches (approximately 76mm).  
24      The first and second bands 72, 74 are preferably  
25      annular bands that extend circumferentially around  
26      the outer surface 54s of the casing 54, although  
27      this configuration is not essential. The first and  
28      second bands 72, 74 typically comprise 1-inch wide  
29      (approximately 26mm) bands of a first resilient  
30      material (e.g. a first type of rubber). The  
31      formation 70 need not extend around the full  
32      circumference of the surface 54s.

1  
2 Located between the first and second bands 72, 74 is  
3 a third band 76 of a second resilient material (e.g.  
4 a second type of rubber). The third band 76  
5 preferably extends between the first and second  
6 bands 72, 74 and is thus typically 3 inches  
7 (approximately 76mm) wide.

8  
9 The first and second bands 72, 74 are typically of  
10 the same depth as the third band 76, although the  
11 first and second bands may be of a slightly larger  
12 depth.

13  
14 The first type of rubber (i.e. first and second  
15 bands 72, 74) is preferably of a harder consistency  
16 than the second type of rubber (i.e. third band 76).  
17 The first type of rubber is typically 90 durometer  
18 rubber, whereas the second type of rubber is  
19 typically 60 durometer rubber. Durometer is a  
20 conventional hardness scale for rubber.

21  
22 The particular properties of the rubber or other  
23 resilient material may be of any suitable type and  
24 the hardnesses quoted are exemplary only. It  
25 should also be noted that the relative dimensions  
26 and spacing of the first, second and third bands 72,  
27 74, 76 are exemplary only and may be of any suitable  
28 dimensions and spacing.

29  
30 As can be seen from Fig. 3c in particular, an outer  
31 face 76s of the third band 76 can be profiled. The  
32 outer face 76s is ribbed to enhance the grip of the

1     third band 76 on the borehole in which the casing 54  
2     is located. It will be appreciated that an outer  
3     surface of the first and second bands 72, 74 may  
4     also be profiled ( e.g. ribbed). The ribbed profile  
5     also helps when the casing 54 is expanded as it  
6     provides a space into which the compressed rubber  
7     can extend or deform into, as rubber is generally  
8     incompressible.

9

10    The two outer bands 72, 74 being of a harder rubber  
11    provide a relatively high temperature seal and a  
12    back-up seal to the relatively softer rubber of the  
13    third band 76. The third band 76 typically provides  
14    a lower temperature seal.

15

16    The two outer bands of rubber 72, 74 are provided  
17    with a number of circumferentially spaced-apart  
18    notches 78. In the embodiment shown, four  
19    equidistantly spaced notches 78 are provided, and as  
20    can be seen from Fig. 3b in particular, the notches  
21    78 do not extend through the entire depth of the  
22    rubber bands 72, 74. The notches 78 are used  
23    because the bands 72, 74 are of a relatively hard  
24    rubber material and this may stress, crack or break  
25    when the outer diameter of the casing 54 is radially  
26    expanded. The notches 78 provide a portion of the  
27    bands 72, 74 that is of lesser thickness than the  
28    rest of the bands 72, 74 and this portion can  
29    stretch when the casing 54 is expanded. The  
30    stretching of this portion substantially prevents  
31    the bands 72, 74 from cracking or breaking when the  
32    casing 54 is expanded. The notches 78 also provide

1       a space into which the rubber may deform or expand  
2       into when the casing 54 is expanded.

3

4       In use, the formation 70 is applied to the outer  
5       surface 54s of the (unexpanded) expandable casing  
6       54. The formation 70 may be applied at axially  
7       spaced-apart locations along the length of the  
8       casing 54, the spacing and number of formations 70  
9       being chosen to suit the particular application.

10

11      An alternative formation 80 that can be applied to  
12      the outer surface 54s of the casing 54 is shown in  
13      Figs 4a and 4b. The alternative formation 80 is in  
14      the form of a zigzag. In this embodiment, the  
15      formation 80 comprises a single (preferably annular)  
16      band of resilient material (e.g. rubber) that is,  
17      for example, of 90 durometers hardness and about 2.5  
18      inches (approximately 28mm) wide by around 0.12  
19      inches (approximately 3mm) deep.

20

21      To provide a zigzag pattern and hence increase the  
22      strength of the grip and/or seal that the formation  
23      80 provides in use, a number of slots 82a, 82b (e.g.  
24      20 in number) are milled into the band of rubber.  
25      The slots 82a, 82b are typically in the order of 0.2  
26      inches (approximately 5mm) wide by around 2 inches  
27      (approximately 50mm) long.

28

29      The slots 82a are milled at around 20  
30      circumferentially spaced-apart locations, with  
31      around 18° between each along one edge 84a of the  
32      band. The process is then repeated by milling

1 another 20 slots 82b on the other side 84b of the  
2 band, the slots 82b on the other side 84b being  
3 circumferentially offset by 9° from the slots 82a on  
4 the first side 84a. The slots 82a, 82b also provide  
5 a space into which the rubber of the formation 80  
6 can expand or deform into when the casing 54 is  
7 expanded.

8

9 In use, the formation 80 is applied to the outer  
10 surface 54s of the expandable casing 54, as with  
11 formation 70. The formation 80 may be applied at a  
12 plurality of axially spaced-apart locations along  
13 the length of the casing 54, the spacing and number  
14 of formations 80 being chosen to suit the particular  
15 application.

16

17 It is preferable that the casing 54 be made of a  
18 corrosion resistant material so that the casing 54  
19 can also be used as a production string up which  
20 hydrocarbons from the reservoir may flow to the  
21 surface. Of course, casing 54 may be coated with a  
22 corrosion resistant material. However, where this  
23 is not possible, it will be necessary to insert an  
24 additional length of cladding 56 that is of a  
25 corrosion resistant material inside the casing 54,  
26 as shown in Fig. 2. It should be noted that the  
27 corrosion resistant cladding 56 is not essential.

28

29 The cladding 56 is preferably also of a ductile  
30 material that is also a corrosion resistant material  
31 so that it can be inserted into the casing 54 and

1     radially expanded so that its OD contacts the ID of  
2     the casing 54. In this way, the overall borehole 50  
3     (or portions thereof) can be lined with casing 54  
4     and clad with cladding 56 by installing the casing  
5     54 as described above, and then the cladding 56 is  
6     inserted into the casing 54 and then radially  
7     expanded so that it contacts an inner surface of the  
8     casing 54. Again, the cladding 56 need not contact  
9     the casing 54 as spacers or the like may be  
10    provided. Also, cement can optionally be used to  
11    fill the annulus between the casing 54 and the  
12    cladding 56.

13

14    Cladding 56 is typically relatively thin (e.g. with  
15    a wall thickness of around 5mm or less) so that it  
16    is easy to radially expand, and also so that it does  
17    not adversely affect the size of the conduit through  
18    which the recovered hydrocarbons flow to the  
19    surface. Thus, the cladding 56 does not restrict  
20    the flow rate of the recovered hydrocarbons or other  
21    fluids.

22

23    It will be appreciated that the cladding 56 may be  
24    provided with formation 70, formation 80 or the like  
25    to provide a seal in the annulus 58 between the  
26    cladding 56 and casing 54, as illustrated in Fig. 2.  
27    It will be generally appreciated that a seal in the  
28    annulus 58 will not be required where the cladding  
29    56 is expanded to fully contact the casing 54 as  
30    there will be no annulus. The seals provided by,  
31    for example, formations 70, 80 or any conventional  
32    method (e. g. a packer) prevent hydrocarbons from

1       the reservoir or well flowing up the annulus 58 and  
2       being lost into the surrounding formation.

3

4       Thus, the method may include the additional step of  
5       providing a length of cladding 56 where it is  
6       required to have a corrosion resistant material in  
7       the borehole 50 (e.g. if the casing 54 is not  
8       corrosion resistant or provided with a corrosion  
9       resistant coating). The cladding 56 can be the same  
10      length as the overall borehole 50, but it will be  
11      appreciated that the length of cladding 56 may  
12      comprise a number of discrete portions, or may be in  
13      the form of a coil, reel or roll for example. The  
14      cladding 56 is then run into the casing 54 and  
15      radially expanded. The cladding 56 can be radially  
16      expanded in the same way as the casing 54 e.g. by  
17      pushing, pulling or otherwise propelling the  
18      expander device therethrough.

19

20      The conventional method of drilling and completing a  
21      borehole generally provides a production annulus 46  
22      between the production string 38 and the casing 34  
23      (Fig. 1). The production annulus 46 is typically  
24      used to run control lines, wires etc from the  
25      surface to downhole, the lines etc being used for  
26      many different purposes such as transmitting power  
27      and data communications from the surface to  
28      apparatus located downhole.

29

30      The production annulus 46 typically acts as a  
31      service conduit also, that is it is usually used to  
32      gain access for remedial and repair operations.

1       Also, the service conduit is used to house cabling  
2       and downhole apparatus and instruments (e.g. flow  
3       sensors, temperature sensors and associated cabling  
4       etc) that monitor various parameters of the  
5       recovered hydrocarbons.

6

7       The service conduit (i.e. production annulus 46) is  
8       generally limited in size resulting in space and  
9       design constraints for the type of apparatus,  
10      instruments and cabling that can be inserted  
11      therein. The size limitation also presents other  
12      problems, such as making the annulus 46 difficult to  
13      access and it is also difficult to install downhole  
14      apparatus and instruments, cabling etc. The  
15      apparatus, instruments and cabling are often damaged  
16      as they are being run into the annulus 46, and there  
17      is also difficulty in passing the apparatus etc  
18      through pressure barriers such as packers.

19

20      If the apparatus or instruments fail or break down  
21      during installation or use, they must be retrieved  
22      from the annulus, which can be very expensive and  
23      time consuming.

24

25      Referring to Fig. 2, it will be noted that an  
26      annulus 58 is provided in the particular embodiment  
27      shown in Fig. 2 and this can be used for the control  
28      lines etc. However, there may be situations where  
29      there is no annulus 58 between the cladding 56 and  
30      the casing 54, for example where the casing 54 is  
31      also corrosion resistant so that the cladding 56 is  
32      not required, or where the cladding 56 is radially

1       expanded to fully contact the inner surface of the  
2       casing 54 or cement is used to fill the annulus 58.

3

4       Thus, the present invention also provides a service  
5       string 62 that is located within the cladding 56 in  
6       the embodiment shown. It will be noted that the  
7       service string 62 can be provided within the casing  
8       54 where no cladding 56 is used. The service string  
9       62 is of a relatively small OD so that it does not  
10      provide an obstruction to the hydrocarbons that will  
11      flow up an annulus 64 between the service string 62  
12      and the cladding 56 (or casing 54).

13

14      The service string 62 can be a string of any  
15      downhole tubular member, but is preferably in the  
16      form of a coil, roll or reel so that it can be  
17      easily dispensed and retrieved from the borehole 50.

18

19      The service string 62 is used to house the control  
20      wires, lines etc and any other control or electrical  
21      cables that are used to control or provide signals  
22      to and from downhole apparatus. The service string  
23      62 may incorporate the downhole apparatus and  
24      instruments, such as flow sensors 66 or intra-well  
25      sensors 68 etc. Thus, the service string 62 could  
26      house cabling that is between the downhole sensors  
27      66, 68 and the surface. The service string 62 may  
28      also be used for chemical injection and gas lift.

29

30      Also, the annulus 64 may contain other downhole  
31      apparatus or instruments, such as flow control  
32      devices 69 or the like. Thus, the service string 62

1 can be used to house any cabling between the flow  
2 control device 69 and the surface so that the device  
3 69 or other apparatus can be controlled and  
4 monitored.

5

6 Where a service string 62 is required, the method  
7 typically includes the additional steps of providing  
8 the service string 62 within the casing 54 or the  
9 cladding 56. The service string 62 is typically  
10 held within the casing 54 or the cladding 56 using  
11 any conventional means, e.g. seals, a packer or the  
12 like. The service string 62 can comprise a number  
13 of discrete portions of drill string for example, or  
14 could be a length of coiled tubing or the like.

15

16 Thus, the invention in certain embodiments provides  
17 a method and apparatus for casing a borehole that  
18 provides significant advantages over conventional  
19 methods. In particular, the method and apparatus of  
20 the invention in certain embodiments provide savings  
21 in terms of costs and rig time, and also obviate the  
22 need to drill different sized boreholes for each OD  
23 of casing. Additionally, there is no requirement to  
24 cement the casing into place as it is radially  
25 expanded to contact the borehole and is generally  
26 held in place due to a frictional contact between  
27 the casing and the borehole.

28

29 The service string in certain embodiments offers  
30 advantages over the conventional method because it  
31 provides a housing for downhole apparatus and  
32 instruments that can be pre-installed before the

1       string is run into the borehole. Thus, the  
2       instruments, cabling etc are protected as they are  
3       run into the borehole by the service string. Also,  
4       if the instruments, apparatus etc within the service  
5       string fail or break down, the service string can be  
6       easily withdrawn from the borehole and the  
7       instruments, apparatus etc repaired or replaced  
8       before the string is run back into the borehole.

9

10      It will also be appreciated that embodiments of the  
11     present invention facilitate easy repair of damaged  
12     portions of casing, lining or cladding. The service  
13     string (where used) would be pulled out of the  
14     borehole, and a portion of casing, lining or  
15     cladding inserted into the borehole. The portion of  
16     casing, liner or cladding is located at or near the  
17     damaged portion that is to be repaired, and  
18     preferably straddles the damaged portion.

19      Thereafter, the portion of casing, liner or cladding  
20     is then radially expanded using an expander device  
21     or an inflatable element (e.g. a packer) so that the  
22     portion of casing, liner or cladding is radially  
23     expanded and thus overlays the damaged portion of  
24     casing, liner or cladding. The entire length of the  
25     casing, liner or cladding need not be fully  
26     expanded, and the casing, liner or cladding can be  
27     tied back to the damaged portion by expanding each  
28     end thereof (e.g. using an inflatable packer).

29      However, the portion of casing, liner or cladding  
30     that is not fully expanded will typically cause a  
31     restriction in the path of the hydrocarbons (or  
32     other fluids) that are being recovered, which could

1       limit the rate at which the hydrocarbons (or other  
2       fluids) can be recovered.

3

4       The portion of casing or cladding that is used for  
5       the repair is typically a thin-walled tubular with a  
6       wall thickness of 5mm or less so that there is no  
7       material change to the diameter of the annulus  
8       created between the service string and the cladding  
9       up which the hydrocarbons flow. Thus, there is no  
10      adverse affect on the flow rate of the recovered  
11      hydrocarbons.

12

13      Certain embodiments of the invention also provide  
14      advantages, as repair or maintenance (e.g. remedial)  
15      operations to the borehole, formation etc are  
16      simpler because a relatively large diameter of  
17      casing can be used along the entire length of the  
18      borehole. In conventional systems, these types of  
19      operation have to be performed from within the  
20      completion string. Restrictions in the ID of the  
21      completion string, for example due to safety valves,  
22      sensors and the like, can make these operations  
23      difficult. Certain embodiments of the present  
24      invention provide an unrestricted ID of casing so  
25      that the repair operations etc can be undertaken  
26      more easily. Even where a service string is used  
27      with the present invention, this is relatively small  
28      and can be removed to facilitate the repair  
29      operations etc, and thereafter replaced.

30

31      Modifications and improvements may be made to the  
32      foregoing without departing from the scope of the

1 present invention. For example, the tubular members  
2 described herein have been radially expanded using  
3 an expander device that imparts a plastic  
4 deformation to expand the member. It will be  
5 generally appreciated that the members can undergo  
6 radial expansion, where only a discrete length of  
7 the member is expanded using an inflatable device  
8 (e.g. a packer). Thereafter, the inflatable device  
9 is moved to an unexpanded portion and inflated to  
10 radially expand the next portion and so on.

11

1        CLAIMS

2

3        1. A method of drilling and/or casing a borehole,  
4        the method comprising the steps of a) drilling a  
5        portion (50a) of the borehole (50) into a formation  
6        (52); b) providing an expandable tubular member  
7        (54); c) running the expandable tubular member (54)  
8        into the portion (50a) of the borehole (50); and d)  
9        radially expanding the member (54).

10

11        2. A method according to claim 1, the method  
12        including the additional steps of drilling one or  
13        more further portions (50b to 50e) of the borehole  
14        (50) extending from the existing portion (50a) of  
15        the borehole (50), providing one or more further  
16        expandable members (54b to 54e), running the or each  
17        expandable member (54b to 54e) into the or each  
18        further portions (50b to 50e) of the borehole (50),  
19        and radially expanding the or each expandable member  
20        (54b to 54e) in the or each further portions (50b to  
21        50e) of the borehole (5).

22

23        3. A method according to claim 2, wherein the or  
24        each further portion (50b to 50e) of the borehole  
25        (50) is drilled at approximately the same diameter  
26        as the or each existing portion(s) (50a to 50d) of  
27        the borehole (50).

28

29        4. A method according to claim 2 or claim 3,  
30        wherein the or each further portion (50b to 50e) of  
31        the borehole (50) extends into the formation (52)  
32        from the or each existing portion (50a to 50e).

1

2       5. A method according to any one of claims 2 to 4,  
3       wherein the or each portion (50b to 50e) of the  
4       borehole (50) comprises one or more lateral and/or  
5       horizontal boreholes drilled from the or each  
6       existing borehole (50a to 50d).

7

8       6. A method according to any preceding claim,  
9       wherein the method includes the additional step of  
10      providing a drill bit to drill the or each portion  
11      (50a to 50e) of the borehole (50) into the formation  
12      (52).

13

14      7. A method according to claim 6, wherein the  
15      drill bit is provided with one or more cutting  
16      elements that are capable of being moved between a  
17      retracted configuration and an extended  
18      configuration.

19

20      8. A method according to claim 7, the method  
21      including the additional step of moving the cutting  
22      elements between the retracted configuration and the  
23      extended configuration.

24

25      9. A method according to claim 8, wherein the step  
26      of moving the cutting elements includes the  
27      additional step of applying pressurised fluid to the  
28      drill bit.

29

30      10. A method according to claim 6, wherein a single  
31      diameter drill bit is used to drill the or each  
32      portion (50a to 50e) of the borehole (50).

1

2       11. A method according to claim 10, wherein the  
3       method includes the additional steps of providing an  
4       underreamer, running the underreamer into the or  
5       each portion (50a to 50e) of the borehole (50), and  
6       actuating the underreamer to increase the diameter  
7       of the or each portion (50a to 50e) of the borehole  
8       (50).

9

10      12. A method according to any preceding claim,  
11       wherein the or each expandable tubular member (54a  
12       to 54e) is radially expanded until at least a  
13       portion of an outer surface (54s) of the member (54a  
14       to 54e) contacts an inner surface of the or each  
15       portion (50a to 50e) of the borehole (50).

16

17      13. A method according to any one of claims 1 to  
18       11, wherein the expandable tubular member (54a to  
19       54e) is radially expanded within the or each portion  
20       (50a to 50e) of the borehole (50) so that an annulus  
21       is created between an outer surface (54s) of the  
22       member (54a to 54e) and the or each portion (50a to  
23       50e) of the borehole (50), and the method includes  
24       the additional step of filling the annulus with  
25       cement to hold the member (54a to 54e) in place.

26

27      14. A method according to any preceding claim,  
28       wherein the step of radially expanding the member  
29       (54a to 54e) includes the additional steps of  
30       providing an expander device, and running the  
31       expander device into the expandable tubular member

1       (54a to 54e) to radially expand the member (54a to  
2       54e).

3

4       15. A method according to claim 14, wherein the  
5       step of running the expander device includes the  
6       step of pushing and/or pulling the expander device  
7       through the member (54a to 54e) to radially expand  
8       the member (54a to 54e) in the or each portion (50a  
9       to 50e) of the borehole (50).

10

11      16. A method according to claim 14 or claim 15,  
12      wherein the method includes the additional step of  
13      resting the or each expandable tubular member (54a  
14      to 54e) on a portion of the expander device whilst  
15      the member (54a to 54e) and device are run into the  
16      or each portion (50a to 50e) of the borehole (50).

17

18      17. A method according to any one of claims 14 to  
19      16, wherein the method includes the additional step  
20      of anchoring at least a portion of the member (54a  
21      to 54e) at or near a starting position of the  
22      expander device.

23

24      18. A method according to any preceding claim, the  
25      method including one, some or all of the additional  
26      steps of e) providing a corrosion resistant  
27      expandable tubular member (56); f) running the  
28      corrosion resistant expandable tubular member (56)  
29      into the or each portion (50a to 50e) of the  
30      borehole (50); and g) radially expanding the  
31      corrosion resistant expandable tubular member (56).

32

1       19. A method according to claim 18, wherein the  
2       method includes repeating steps e) to f).

3       .

4       20. A method according to any preceding claim, the  
5       method including the additional step of providing a  
6       service string (62) within the expandable tubular  
7       member (54) and/or the corrosion resistant  
8       expandable tubular member (56).

9       .

10      21. Apparatus for casing a borehole , the apparatus  
11       comprising at least one length of expandable tubular  
12       member (54), and an expander device that is capable  
13       of radially expanding the member (54) in the  
14       borehole (50).

15      .

16      22. Apparatus according to claim 21, wherein the or  
17       each expandable tubular member (54a to 54e) is of a  
18       length that is substantially the same length as the  
19       or each portion (50a to 50e) of the borehole (50).

20      .

21      23. Apparatus according to claim 21 or claim 22,  
22       wherein the or each length of expandable tubular  
23       member (54a to 54e) is provided by coupling discrete  
24       lengths of expandable tubular member (54a to 54e)  
25       together.

26      .

27      24. Apparatus according to claim 21 or claim 22,  
28       wherein the or each length of expandable tubular  
29       member (54) is provided from a roll, reel, coil or  
30       drum of expandable tubular member (54).

31

1       25. Apparatus according to claim 21 or claim 22,  
2       wherein the or each length of expandable tubular  
3       member (54a to 54e) comprises a plurality of  
4       discrete lengths that are inserted into the or each  
5       portion (50a to 50e) of the borehole (50) in an  
6       overlapping arrangement so that one end of a  
7       subsequent member (54a to 54e) overlaps one end of a  
8       previous member (54a to 54e).

9

10      26. Apparatus according to any one of claims 21 to  
11      25, wherein the or each expandable tubular member  
12      (54a to 54e) is provided with a friction and/or  
13      sealing material (70, 80) on its outer surface.

14

15      27. Apparatus according to any one of claims 21 to  
16      26, wherein the apparatus includes one or more  
17      spacers located between the or each expandable  
18      tubular member (54a to 54e) and the or each portion  
19      (50a to 50e) of the borehole (50).

20

21      28. Apparatus according to any one of claims 21 to  
22      27, wherein the or each expandable tubular member  
23      (54a to 54e) is of a corrosion resistant material,  
24      or coated therewith.

25

26      29. Apparatus according to any one of claims 21 to  
27      28, wherein the apparatus includes at least one  
28      corrosion resistant expandable tubular member (56)  
29      located within the or each expandable tubular member  
30      (54a to 54e).

31

1       30. Apparatus according to claim 29, wherein the  
2       corrosion resistant expandable tubular member (56)  
3       is of a length that is substantially the same length  
4       as the or each portion (50a to 50e) of the borehole  
5       (50) and/or the or each expandable tubular member  
6       (54a to 54e).

7

8       31. Apparatus according to claim 29 or claim 30,  
9       wherein the corrosion resistant expandable tubular  
10      member (56) has a wall thickness in the order of 5mm  
11      or less.

12

13      32. Apparatus according to any one of claims 29 to  
14      31, wherein the apparatus includes a service string  
15      (62).

16

17      33. Apparatus according to claim 32, wherein the  
18      service string (62) is located within the expandable  
19      tubular member (54a to 54e) and/or the corrosion  
20      resistant expandable tubular member (56).

21

22      34. Apparatus according to claim 32 or claim 33,  
23      wherein the service string (62) is used as a conduit  
24      to house cables and wires that are used to control  
25      downhole tools, apparatus and instruments.

26

27      35. Apparatus according to any one of claims 32 to  
28      34, wherein the service string (62) is provided with  
29      downhole tools, apparatus and instruments.

30

1       36. Apparatus according to any one of claims 32 to  
2       35, wherein the service string (62) comprises a  
3       corrosion resistant tubular member (56).

4

5       37. Apparatus according to any one of claims 32 to  
6       36, wherein the service string (62) has a wall  
7       thickness in the order of 5mm or less.

8

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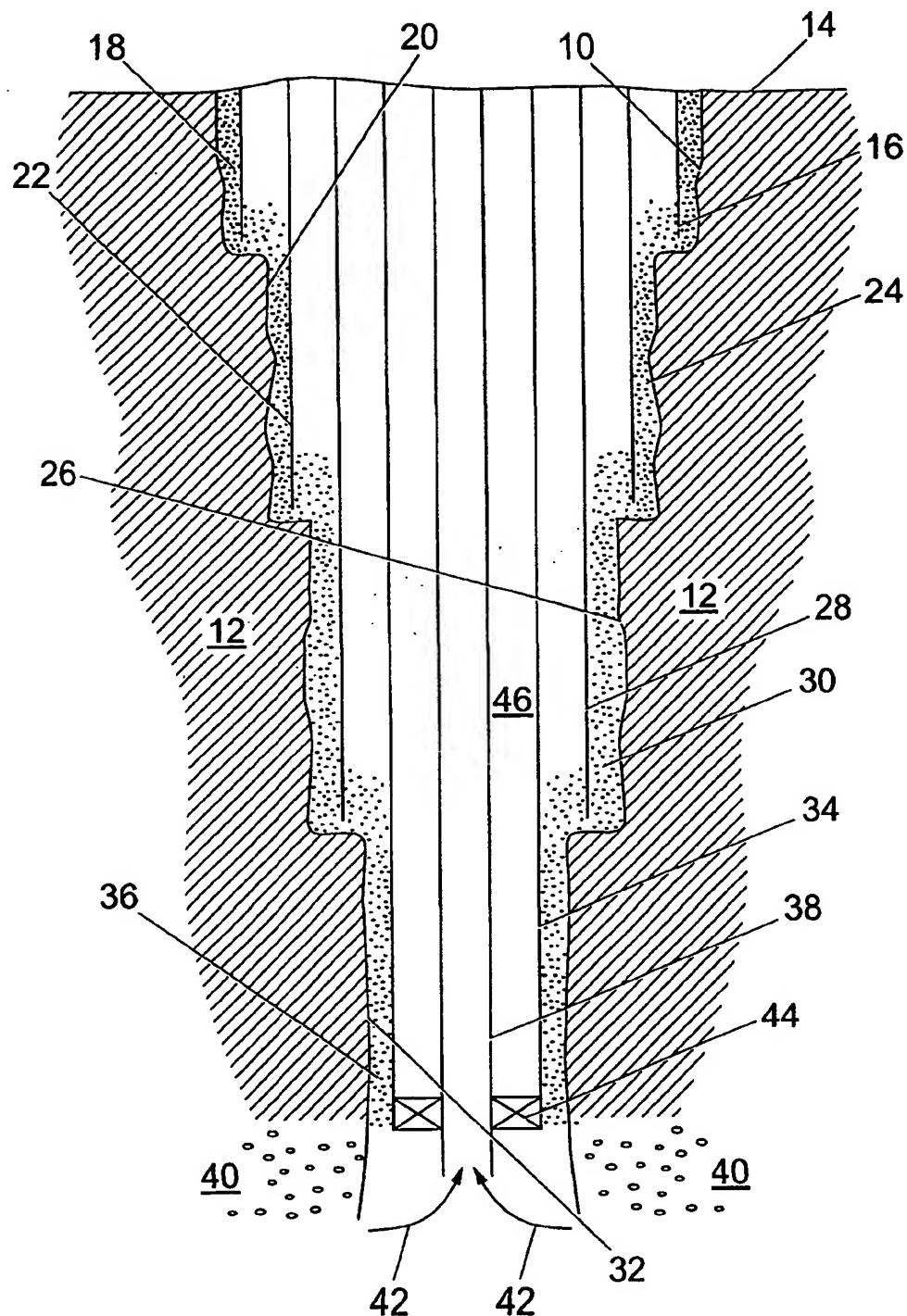


Fig. 1

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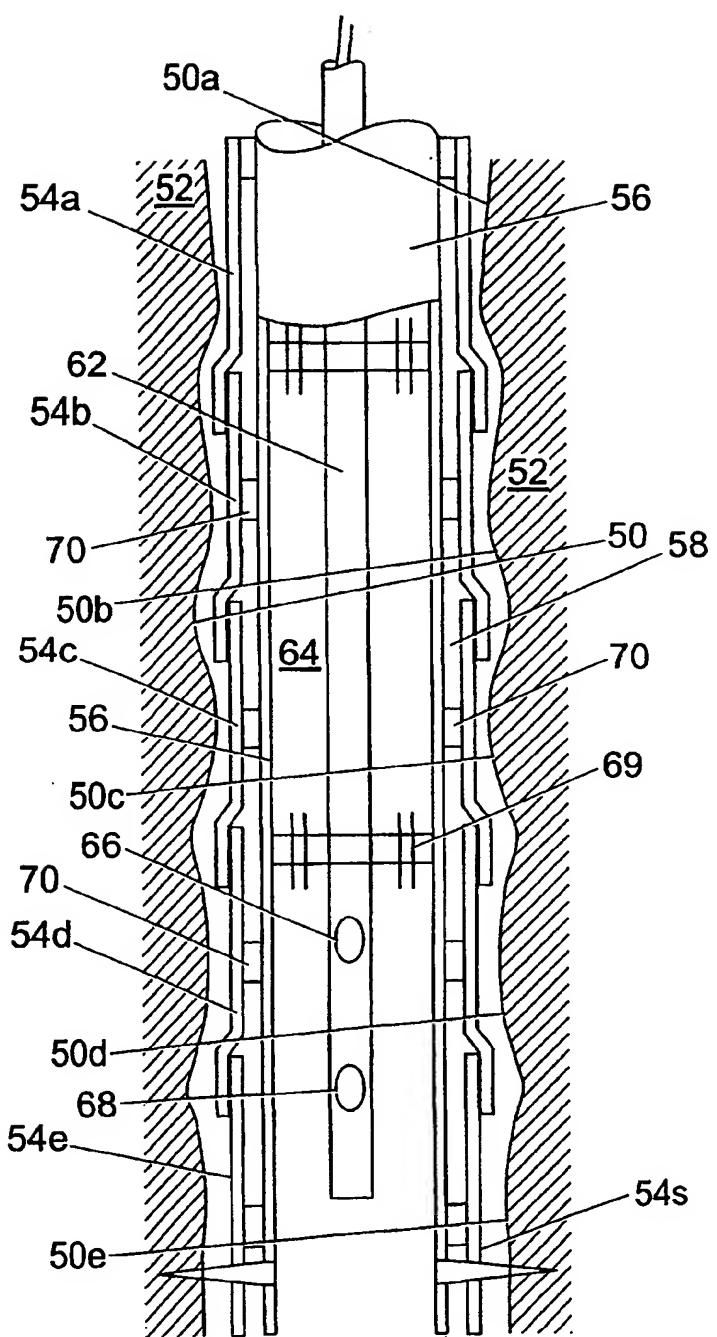
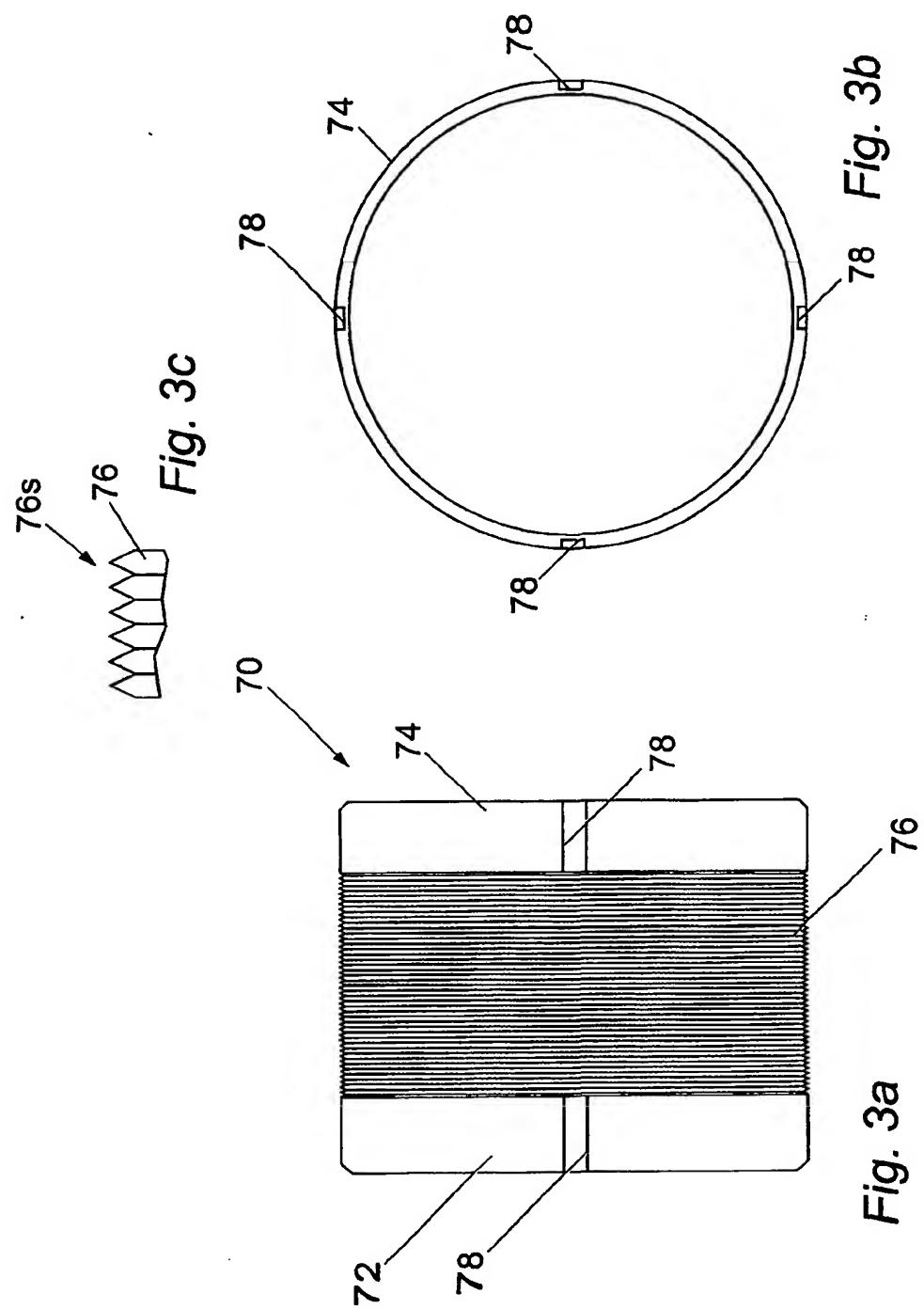
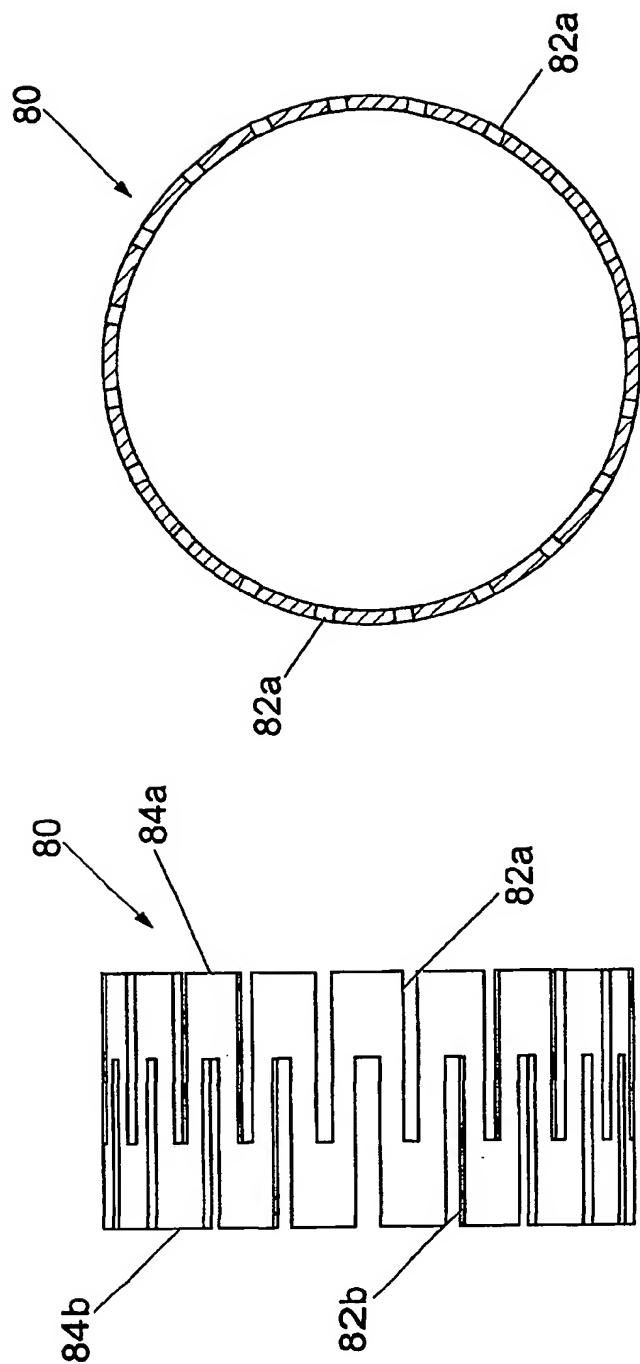


Fig. 2

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*Fig. 4b*

*Fig. 4a*

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